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THE DENVER FLASH FLOOD PREDICTION PROGRAM
OF THE
URBAN DRAINAGE & FLOOD CONTROL DISTRICT OF DENVER
CONDUCTED BY
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Report for the 1986 Season

15 April - 15 September

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INTRODUCTION

In 1979 the Urban Drainage & Flood Control District (District) sponsored flash flood prediction program (F2P2) for the six county Denver Metropolitan area. The counties served by the program include: Denver, Adams, Arapahoe, Boulder, Douglas and Jefferson. This report summarizes the degree of success achieved in forecasting the occurrence of excessive convective rainfall and upslope rainfall in the District during the period, 15 April to 15 September 1986.

VERIFICATION OF PROGRAM RESULTS

The 1986 operational season for the F2P2 continued in the successful tradition of the previous seven years and achieved a high degree of local forecast accuracy. All major event days were very accurately forecast including June 8th, June 16th and August 2nd. The lone disappointment of the season occurred on May 15th when thunderstorm advisories were issued for rainfall of 0.50 inches in thundershowers. One storm intensified over the Denver Tech Center and produced an estimated 1.50 inches of rain in one hour which produced a brief street flooding episode on Goldsmith Gulch in southeast Denver County. This incident represents only the second event since 1979 that occurred in the District without a Message issuance.

The seasonal verification statistics are presented in Table 1 while the message day forecasts are presented for each county in Table 2. Additionally the issuance of thunderstorm advisories (TA) is included in the verification tables. A thunderstorm advisory was issued for those days when severe or significant thunderstorm activity was expected or occurred but rainfall from the storms was below flash flooding or urban flooding potential. The TA's were readily accepted by the counties and were judged as an effective way to eliminate confusion or concern on heavy thunderstorm days about the storms' rainfall producing capabilities.

Before viewing the 1986 season statistics the reader must be aware of several important considerations:

- a. The F2P2 operational day is defined as 0000-2400MDT with normal operating hours 0600-2200MDT unless MESSAGES are in effect when 24-hour operation commences.
- b. An excessive convective or urban street flooding event is defined as the reported occurrence of excessive rainfall, usually from thunderstorms, which causes flash flooding, stream flooding or street flooding. In general thunderstorm rainfall of over 0.50"/15-30 minutes or upslope rainfall of 1.00"/6 hours causes a degree of problem. All events must occur within District limits.
- c. An excessive convective rainfall (ECR) day is defined as an operational day on which atleast one ECR event occurs within the District boundaries.
- d. A correct ECR forecast required that all ECR events occurred in counties which had valid F2P2 MESSAGES in force during the time of occurrence.

These considerations within the F2P2 insure that a high degree of site-specific forecasting is maintained and that verification rules are consistent with previous years. The degree of success that has been demonstrated in the Denver F2P2 is considered by some to represent the state-of-the-art in flash flood and excessive convective rainfall forecasting.

The verification results for the season are presented in Table 1 and significant points are listed below for the reader to ponder:

- a. F2P2 MESSAGES were issued for 35 days during the 154 days of the operational season. Thunderstorm advisories were issued on an additional 13 days which did not meet MESSAGE criteria but approached operational concern.
- b. Of the 35 MESSAGE day forecasts issued, 30 MESSAGE day forecasts verified and 5 did not. Thus 86 percent of the MESSAGE day forecasts verified and 14 percent were false alarms.
- c. ECR events occurred on 31 days during the operational season. MESSAGES were issued for 30 of the 31 event days. The lone exception occurred on May 15th and is discussed earlier in this report. Thus the probability of detection of an ECR event day by the MESSAGES was 97 percent.
- d. The overall accuracy of the MESSAGE/NO MESSAGE forecast includes 30 correct MESSAGE DAY forecasts and 118 correct NO MESSAGE DAY forecasts. Thus 148 of the 154 daily forecasts was correct achieving 96 percent accuracy.
- e. Comparisons between 1986 and the average of the past 5 years(1981-85) show most operational categories similar in performance. The 1986 false alarm rate was lower but one unforecast event occurred.

Table 1 Comparison of Operational Results of the UDFCD F2P2 between the 1986 Season and the Five Year Average(1981-1985).

	1986	81-85
Average number-MESSAGE days	30	31
False Alarm Rate - MESSAGES	14%	17%
Probability of Detection	97%	100%
Overall ECR Day Forecasts	96%	96%

MAJOR EVENT DAYS

Three major event days occurred during the 1986 operational season: June 8th - the Aurora tornado day; June 16th - Severe Lightning/Heavy Rain Supercell; and, August 2nd - Northrn District Mega-Hailstorm. On each of these days appropriate MESSAGES were issued with sufficient lead-time for local agencies to respond to an above normal threat day. The most extraordinary of these occurred on June 8th when a tornado occurred on the southeast Denver-Aurora border during the afternoon. The tornado dropped from a supercell thunderstorm that was rapidly intensifying along a shear line. The MESSAGES issued between 1223-1238L indicated 1-2"/hour rainfall potential and the chance of a tornado in eastern parts of the District in Adams, Arapahoe and Douglas Counties. The tornado actually touched down in the District between 1600 and 1700L. The early recognition of the tornado threat potential represents a major un-focused skill latent within the program.

On June 16th a line of severe thunderstorms formed in the South Platte Valley during the evening and hammered on the northwest corner of Denver County, northeastern Jefferson County and western Adams County. Over 1200 cloud-to-ground lightning strikes occurred from 1730 to 2130L. Extensive street flooding occurred in northwest Denver, Thornton, Federal Heights and Littleton.

The premier storm event of the operational 1986 season occurred on August 2nd and just clipped the northern third of the District. It is estimated that over \$70 million in hail, rain and related damage occurred in a swath from northeastern Boulder to southwestern Weld to northwestern Adams Counties. About 2.75" of rain fell in 15 minutes in parts of the District. A re-constitution of this event is planned for later this year. Early estimates of total storm rainfall indicate that amounts of 6-8 inches may have been produced.

OBSERVATIONS

The F2P2 continues to develop expertise in refining the degree of detail in operational MESSAGES. About 57 percent of the MESSAGES (20) were issued for areas of 4 counties or less. On four days MESSAGES were issued for only one or two counties which significantly reduced the area of enhanced alert required. In addition thunderstorm advisories(TA) were issued for 13 days that approached MESSAGE criteria. The TA has proven to be an effective tool in bridging the support gap between severe weather, heavy thunderstorm and MESSAGE days.

CONCLUSIONS

The Urban Drainage & Flood Control District sponsored flash flood prediction program performed better than 5 year averages in most prediction categories. Plans are being formed to improve on this record during the 1987 operational year ahead.

Verification and Summary of 1986 Denver F2-P2
Excessive Convective Rainfall Event Day
MESSAGES

[illegible]

Table 2b

Verification and Summary of 1986 Denver F2-P2
Excessive Convective Rainfall Event Day
MESSAGES

April 15 to September 15 1986

EVENT DAYS	DATE	VERIF	MESSAGE TYPE	COUNTIES							# MESS ISSUED	# TA'S ISSUED
				AR	AD	BO	DE	DO	JE	AU		
12	7-5	+	TA	1	1	1	1	1	1	1		7
	7-6	+	M1-T2	1	1	1	1	1	1	1	7	
	7-8	+	TA	1				1	1	1		4
	7-9	+	TA					1	1			2
13	7-10	+(?)	M1-T2		1				1		2	
14	7-16	+	M1-T2		1	1	1		1		4	
15	7-17	+	M1-T2	1			1	1	1		4	
16	7-18	+	M1-T2	1	1	1	1	1	1	1	7	
17	7-20	+	M1-T2	1	1	1	1	1	1	1	7	
18	7-21	-	M1-T2					1			1	
19	7-22	+	M1-T2			1		1	1		3	
20	7-23	+	M1-T2	1			1	1	1	1	5	
	7-31	+	TA	1	1	1	1	1	1	1		7
21	8-2	+	M1-T2	1	1	1	1	1	1	1	7	
22	8-3	+	M1-T2	1	1	1	1	1	1	1	7	
23	8-4	+	M1-T2	1	1	1	1	1	1	1	7	
24	8-7	+	M1-T2		1	1	1				3	
	8-8	+	M1-T2	1	1	1	1	1	1	1	7	
25	8-9	-(?)	M1-T2	1	1				1	1	4	
27	8-10	-	M1-T2	1	1	1	1	1	1	1	7	
28	8-12	+(?)	M1-T2	1	1	1	1	1	1	1	7	
	8-13	+	TA			1	1					2
29	8-19	-(?)	M1-T2	1	1		1	1	1		5	
30	8-21	+	M1-T2	1				1		1	3	
31	8-22	+	M1-T2	1	1		1	1	1	1	6	
32	8-23	+	M1-T2	1	1	1	1	1	1	1	7	
33	8-30	+	M1-T2	1			1	1	1	1	5	
34	9-2	+	M1-T2		1	1		1	1		4	
35	9-6	+	M1-T2	1				1	1	1	4	
				AR	AD	BO	DE	DO	JE	AU		
TOTAL MESSAGES				28	26	22	27	30	30	28		

TOTAL THUNDERSTORM ADVISORY 10 6 8 7 10 10 10

* M1-T2 NEEDED FOR ARAPAHOE COUNTY/ DENVER COUNTY BUT NOT ISSUED

? VERIFICATION NOT FINALLY CONFIRMED PENDING SOURCE SEARCH

+ MESSAGE VERIFIED WITHIN THE DISTRICT DUE TO ECR EVENT OCCURRENCE

- MESSAGE DID NOT VERIFY WITHIN THE DISTRICT

TA = THUNDERSTORM ADVISORIES